

Naval Submarine Medical Research Laboratory

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RELIABILITY OF THE SUBSCREEN PSYCHOLOGICAL SCREENING INVENTORY

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Reliability of the SUBSCREEN
Psychological Screening Inventory

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Naval Submarine Medical Research Laboratory
Report 1206

Naval Sea Systems Command Task

Naval Medical Research and Development Command
Research Work Unit - 5403

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SUMMARY PAGE

THE PROBLEM

SUBSCREEN is a 240 item psychological inventory used to evaluate prospective submariners' ability to adjust to Naval Submarine School (NAVSUBSCOL) and subsequent submarine service, and refer students with atypical results for mental health interviews. With any screening tool reliability of the procedure is always an important issue. Results of a 1990 study by Katz and Rexer indicated that several SUBSCREEN subscales had low reliability. Some of the items in these subscales had an unusually high number of neutral or missing responses, while others demonstrated negative intercorrelations with the subscale to which they belonged. Additionally, the means and standard deviations currently being used to calculate subscale standardized scores needed to be reevaluated to ensure consistent and accurate SUBSCREEN results.

THE FINDINGS

All SUBSCREEN subscales were found to have moderate to high reliability (Cronbach's [1951] alpha from .65 to .87) after correcting the scoring of the items that correlated negatively with their respective subscales. The continued existence of items with a high number of neutral or missing responses was confirmed and implementation of the new means and standard deviations was recommended based on a renorming procedure.

THE APPLICATION

Improved accuracy and consistency of SUBSCREEN results.

ADMINISTRATIVE INFORMATION

This investigation was conducted under Naval Medical Research and Development Command Research Work Unit 5403, "Psychological screening and testing in support of submarine training," in response to a Naval Sea Systems Command Work Request. The views expressed in this report are those of the authors and do not reflect the official policy or position of the Department of the Navy, Department of Defense, or the U.S. government. This report was approved for publication on 06 Jun 1997 and designated Naval Submarine Medical Research Laboratory Report 1206.

ABSTRACT

SUBSCREEN is a psychological screening tool used at the Naval Submarine School (NAVSUBSCOL) to assess the ability of prospective submariners to adjust to both NAVSUBSCOL and subsequent submarine service. Standardized scores are calculated for each student for each of the 27 subscales to determine how the student's scores compare to a group of a large number of previously tested NAVSUBSCOL students. An unpublished reliability analysis by Katz and Rexer (1990) suggested low reliabilities of several SUBSCREEN subscales and identified the items that contributed to the low subscale reliabilities. This early work had a relatively small number of test results in the comparison group and the authors realized the need to provide a more definitive analysis of the SUBSCREEN's reliability in order to recommend changes to certain subscales and items.

A reliability study similar to Katz and Rexer's was conducted using a larger data set containing 19,517 observations to verify their findings. Initial results closely resembled Katz & Rexer's earlier work. Two types of problems were found in certain items: some were scored incorrectly, and some yielded an unusual number of missing or neutral responses. A corrected scoring procedure was instituted for items in the first category. Review and possible elimination of the items yielding missing or neutral responses is ongoing. Following corrections in the scoring procedure, the reliability analysis was performed again to re-examine the subscales' reliability. The reliability of the three subscales demonstrating low reliability in the earlier study improved greatly after scoring inconsistencies were corrected. Means and standard deviations were obtained from the larger database for 25 of the subscales and the new values are now included in the scoring process.

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Reliability of the SUBSCREEN Psychological Screening Inventory

Submarine service involves prolonged periods of time underwater and little, if any, contact with the outside world. This, combined with the fact that psychiatric help is unavailable while onboard, makes the identification of individuals with mental health problems extremely important. The identification and exclusion of such individuals assures that the mental health of submariners is of the highest quality. This, in turn, helps to assure crew safety as well as improved general efficiency and cost-effectiveness for the Navy.

The SUBSCREEN testing process is used to identify candidates that are potentially unsuitable for Naval Submarine School (NAVSUBSCOL) and/or submarine service because of psychological or motivational difficulties. Those identified are referred to the Psychiatry Department of the Naval Hospital on the submarine base Groton, CT for a mental health status interview.

Developed in 1986, the SUBSCREEN's 240 items comprise 27 independent subscales and procedural scores. Procedural scores are subscales calculated through the use of composite scores. Composite scores are values that are derived either by combining several subscale values or by examining subjects' response patterns (e.g., the number of neutral responses). Procedural scores typically measure constructs not overtly evaluated by question content. For instance, SUBSCREEN contains an Extreme subscale that examines a student's response pattern to determine the frequency with which he is responding "Strongly Agree" or "Strongly Disagree."

The inventory is administered to all Basic Enlisted Submarine School (BESS) students during their first week of training at the Naval Submarine Base in Groton, CT.

The scoring algorithm generates referrals based on the scores of 14 of the 27 subscales. These 14 subscales relate to Diagnostic and Statistical Manual (DSM-IV) (1994) psychological dimensions and/or reflect conditions which make an individual unacceptable for submarine service (e.g. claustrophobia, suicidal ideation, sleep walking) according to the Manual of the Medical Department (1992). The remaining 13 subscales relate to non-classifiable dimensions (primarily motivation). The scores from these subscales, which do not automatically generate referrals, are also considered by the Naval Submarine Medical Research Laboratory (NSMRL) examiner when making the final determination regarding referrals. The reader is referred to Schlichting (1993) for a comprehensive discussion and review of the SUBSCREEN inventory.

Of all enlisted students tested between 1988 and 1995, approximately 9.7 percent were referred to the Psychiatry Department; of those referred, 75 percent were returned to BESS, 9.1 percent were transferred to the surface fleet, and 15.9 percent were discharged from the Navy (Schlichting, 1993).

In the construction and maintenance of any screening tool it is essential that the tool demonstrate internal reliability and that new norms be developed as the number of scores available increases and substantial time passes (Cronbach, 1990). In 1990, Katz and Rexer examined the internal consistency of 25 of the 27 SUBSCREEN subscales,¹ renamed the instrument, and identified

¹ The two subscales not included in the analysis are the procedural subscales. Reliability analysis is not appropriate for these composite subscales.

problem items. While this investigation found that most of the 25 subscales demonstrated high levels of reliability ($\alpha > .70$), the Self Critical, Problems Submarine School, and Uncertain About Submarines subscales displayed moderate or low reliability. Katz and Rexer recommended that the subscales demonstrating inadequate reliability be re-examined and that some of the items be re-worded or deleted to improve the subscales' internal consistency.

As part of a renorming procedure, an analysis of the means and standard deviations indicated that the newly calculated values (based on 6,721 subjects) "failed to closely match the original sample's subscale means and standard deviations" (Katz & Rexer, Unpublished, 1990, p. 6) calculated in 1986 and based on a sample of approximately 800 subjects. Upon Katz and Rexer's recommendation, the new means and standard deviations were implemented in 1990. Of the fourteen problem items identified in the study, five were so classified because of a large number of neutral or missing responses (450 or more [$\geq 6.70\%$]). The remaining nine problem items were found to have negative item-total corrected correlations within their respective subscales. The scoring algorithm was subsequently adjusted to exclude one of these nine items from the computation of its subscale (Uncertain About Submarines) score; however, the item was left in the inventory. While identification of these fourteen problem items was performed by Katz and Rexer, with the exception of the one item listed above, examination of the specific content of each question, within the context of its subscale, was not conducted.

The purpose of the present investigation was to perform a reliability analysis similar to Katz and Rexer's to verify their earlier findings. If the findings indicated

that the problems they identified still exist, the problematic items and the scoring routine would be examined to determine where the difficulty lies. If the scoring routine was identified as the source of the problem it would be modified to correct for the negative correlations. The reliability analysis would then be re-run to: 1) determine the internal consistency of the subscales; 2) determine which specific SUBSCREEN items yield disproportionate quantities of neutral responses or responses that do not correlate well with the other items in their respective subscales; 3) revise the means and standard deviations to reflect the larger number of student scores now available.

Methods and Materials

Participants

Subjects consisted of 19,517 BESS students enrolled in training from 1988 through 1995. The median age of these males was 20.0 years, and the median educational grade level was 12.0. Class sizes varied, ranging from 10 to 181 subjects, and approximately 350 classes were tested over the seven year period.

Design and Procedure

SUBSCREEN testing of BESS students typically occurred during the first week of a five week training course. Test administration usually took place each Monday, beginning at 0730 and ending by 0900. As part of the consent process, students were informed of the purpose of the test and the percentage of students typically referred for further evaluation. They were also informed that psychological screening via this test is a requirement of NAVSUBSCOL; however, students are not required to provide an identifying social security number. After the introduction and

reading the Privacy Act statement aloud, any student's questions were answered. Finally, students signed consent-to-participate and privacy act forms.

Data Scoring/Handling

Standard Trans-Optic® (National Computer Systems Inc., Columbia, PA) computer scan sheets were used to obtain each student's responses to the 240 items. Subjects rated how closely they agreed with each item by selecting one of five possible responses: "A" Strongly Agree; "B" Agree; "C" Neutral; "D" Disagree; or "E" Strongly Disagree. Upon completion of the testing, response sheets were scanned and computer scored by an algorithm that computed the 27 standardized subscales and identified those individuals whose scores met or exceed referral criteria. The resulting computerized data and output files were read into a Statistical Package for the Social Sciences (SPSS) data file. All statistics were computed using SPSS for Windows, version 6.1 (SPSS, Chicago, IL.).

Accuracy of the data was ensured by examining the data in a number of ways. The process began with a class by class verification of the number of response sheets and matching electronic records. Additionally, all social security numbers, dates of birth, and BESS class numbers were checked for accuracy, and, in cases where inconsistencies occurred, corrected by referring to the hardcopy. Class rosters provided by BESS were also used to resolve discrepancies in this demographic data. Finally, random samples of data (the 240 raw item scores and the standardized subscale scores) were checked against the Trans-Optic® sheets and the referral output data to ensure that the data file values were identical to the original data. All values from these random samples matched hard-

copy values. These processes are consistent with commonly accepted methods of data-handling and help to insure the integrity of the data (Novick, 1985).

Results

Reliability

Reliability was determined by calculating a coefficient alpha (Cronbach, 1951), which was used to determine inter-item consistency for each subscale. For instance, a coefficient of .70 signifies that 70% of the variance in scores depends on true variance in the trait measured. The preliminary reliability analysis revealed that 22 of the 25 subscales demonstrated moderate to high alpha reliabilities (alpha of .5 or above). The three subscales with inadequate reliability were the Self Criticism, Problems Submarine School, and Uncertain About Submarine subscales. This result mirrored Katz and Rexter's earlier findings. For the sake of brevity, the preliminary reliability analysis is not presented in tabular form. After an examination of the item content and the scoring algorithm was conducted, it was determined that modifications to the scoring procedures were needed to correct for the negative item-to-scale correlations found in these subscales. Additionally, modifications were also needed to correct for negative item-to-scale correlations in the Social Isolate and Impulsive subscales. (These modifications are fully described within the Problem Items section, below.) Following these corrections the reliability analysis was performed again. Results indicated moderate to high reliability for all 25 subscales, with alpha values ranging from .65 to .87 (see Table 1).

Table 1. Comparison of Means, Standard Deviations and Alpha Reliabilities by Subscale.

SUBSCREEN Subscale	Katz and Rexer			Theriaque and Schlichting		
	Mean	Standard Deviation	Alpha Reliability	Mean	Standard Deviation	Alpha Reliability
Distortion	2.92	0.38	0.71	2.96	0.37	0.73
Good Impression	3.23	0.31	0.79	3.24	0.31	0.81
Mistake Joining Subs	1.77	0.44	0.79	1.76	0.45	0.80
Uncertain About Subs	2.37	0.41	0.54	2.20	0.51	0.72
Conditional Submarine	1.93	0.49	0.72	1.89	0.48	0.74
Unconditional Submarine	3.05	0.46	0.75	3.09	0.46	0.77
Problems Submerging	1.98	0.45	0.66	1.93	0.44	0.68
Problems Sub School	2.40	0.28	0.03	1.90	0.42	0.74
*Physical Well-being	1.68	0.34	0.73	1.65	0.34	0.74
*Low Situational Ctrl	2.16	0.38	0.76	2.11	0.38	0.77
*Nervous or Worrying	2.24	0.37	0.76	2.19	0.36	0.77
*Depressed Mood	1.81	0.44	0.86	1.76	0.44	0.87
*Coercive Attitudes	2.05	0.30	0.71	2.03	0.30	0.74
*Aggressive/Destructive	1.90	0.36	0.72	1.87	0.36	0.73
*Problems Home/School	1.90	0.39	0.76	1.87	0.39	0.78
*Social Isolate	2.11	0.32	0.62	2.07	0.35	0.70
*Impulsive	2.31	0.32	0.67	2.15	0.34	0.73
*Social Support	3.12	0.37	0.68	3.20	0.39	0.70
*Unusual Thoughts	1.95	0.38	0.72	1.90	0.38	0.75
*Unusual Physical Complaints	1.62	0.38	0.77	1.60	0.38	0.79
*Suicide Subscale	1.53	0.42	0.78	1.51	0.41	0.79
*Claustrophobic Feelings	1.93	0.40	0.73	1.89	0.40	0.76
Problems Nuclear	1.71	0.42	0.63	1.72	0.42	0.65
Dependency	2.34	0.34	0.68	2.35	0.33	0.69
Self Criticism	2.41	0.26	0.18	2.19	0.39	0.73

Note: Bolding indicates improvement in reliability of subscales where items were reverse-scored or eliminated.

* subscales used by the scoring algorithm in the referral process.

Problem Items

The second question addressed in this study related to the nature of the problem items identified in Katz and Rexer's 1990 study. All of the problem items noted in the earlier study were re-identified as problem items in the current (initial) reliability analysis. As noted above, this confirmation led the researchers to further examine item content and scoring methods for those items that correlated negatively with other subscale items. Many of these items were found to be correctable by reversing the score of the question. The rationale for this reverse-scoring procedure is fully explained in the Discussion section below.

Specifically, two items in the Problems Submarine School subscale, three items in the Self Criticism subscale, and one item in each of the Social Isolate, Impulsive, and Dependency subscales were correctable by adjusting the items' scoring. Adjustments were made by recoding subjects' responses (A=D, B=C, C=B, D=A) for the items in question.² Of the five subscales listed above, only the Social Isolate and Impulsive subscales are used as referral criteria by the scoring algorithm.

Problem items that contained an unusual number of missing or neutral responses were determined through the use of Katz and Rexer's criterion. That is, any

item with 6.71 percent (n=1310) or more missing or neutral responses was considered a problem item. Five items, contained in three subscales, were identified. Specifically, two items in the Coercive Attitudes subscale (7.00% and 8.53% missing/neutral), two items in the Unconditional Submarine subscale (9.64% and 10.88%), and one item in the Uncertain About Submarines subscale (8.2%) were found to have a disproportionate number of missing and/or neutral responses. Of these three subscales only the Coercive Attitudes subscale is used as a referral criterion by the scoring algorithm. These items are currently under review for possible re-wording or elimination from the inventory.

Renorming

The third issue addressed in this study involved the renorming of the SUBSCREEN. As is standard for renorming procedures, the nearness of the mean of the standardized scores to zero and standard deviation to one indicates the adequacy of the scoring procedure to calculate standardized values (Katz & Rexer, 1990; SPSS, 1993). Table 1 contains the new subscale means and standard deviations (i.e. after modifications to the scoring routine were made) as well as Z-score means and standard deviations based on Katz and Rexer's values. The Z-score means and standard deviations for all 25 subscales fluctuated to some degree, with the greatest deviations found in the Impulsive, Uncertain About Submarines, Problems Submarine School, and Self Criticism subscales (see Table 2). Of these, only the Impulsive subscale is used as a basis for referral by the scoring algorithm.

While no formal hypotheses were considered in relation to the renorming

² Note that subjects initially had five possible responses ("A" Strongly Agree; "B" Agree; "C" Neutral; "D" Disagree; "E" Strongly Disagree), however, during the scoring process all items' scores are routinely converted to a four point scale by removing the neutral responses from the scoring algorithm. The removal of these neutral responses took place before the recoding of the subjects' responses. It should also be noted that, as part of the typical scoring process, alphabetic labels are converted to their numerical equivalents (A=1, B=2, C=3, D=4) to allow for mathematical computations.

procedure, the probability of observing the calculated standardized means was evaluated through the use of a normal distribution table (Howell, 1992). Probabilities for each mean were determined by examining the smaller portion of the area under the curve for the mean of each subscale. For instance, the mean of the standardized scores for the Impulsive subscale is .98. By looking up this value in the normal distribution table we find that the smaller portion of the area beyond the Z value is .1635. This value is then halved because our test is two-tailed (.1635/2=.08). Thus, we can say that if we take a random sample of standardized scores on the Impulsive subscale from an infinite population and calculate the mean, the probability of observing a mean of .98 is .08.

Discussion

Cronbach's alpha was used as the statistic of reliability. Essentially a measure of internal consistency, there are several interpretations of Cronbach's alpha. One involves interpreting the alpha value as "the correlation between a test or subscale and all other possible tests or subscales containing the same number of items, which could be constructed from a hypothetical universe of items that measure the characteristic of interest" (SPSS, 1993, p. 147). Cronbach's

alpha can also be interpreted as the squared correlation of the observed score an individual obtains on a given subscale or test and the subject's true score were he questioned on all possible items (SPSS, 1993, p. 147).

Cronbach's alpha is similar to a correlational coefficient. Its values typically range from 0 to 1. As with correlational coefficients, the nearer the absolute value is to 1, the stronger the association. Typically, values between 0.00 and .39 are considered "low," between .40 and .69 are considered "moderate," and between .70 and 1.00 are considered "high" (Kerlinger, 1986; Henderson, Morris, & Fitz-Gibbon, 1987).

Based on the determination that the scoring of several SUBSCREEN items had not been properly recoded, a brief explanation of the rationale for recoding is in order. Historically, the scoring algorithm recodes a response of A or B to D or C, respectively, if an answer of A or B is considered undesirable or problematic.

Because some inventory items are worded negatively and others positively, not all responses are recoded. A simplistic example will help to clarify. If the SUBSCREEN item were the following: "I feel closed-in when I am indoors" and a student's response was A or B ("Strongly Agree" or "Agree") recoding of the response

Table 2. Z-Score Means and Standard Deviations: Problem Subscales.

SUBSCREEN Subscale	Mean	Standard Deviation	p
*Impulsive	0.98	-0.11	0.080
Uncertain About Submarines	-0.43	1.25	0.170
Problems Submarine School	-1.83	1.52	0.015
Self Criticism	-0.85	1.50	0.100

Note that these subscales include the corrected scoring of problem items. * refers to subscale used by the scoring algorithm in referral process.

would be in order. In this case, agreement to the item would necessitate a higher value (4 or 3, respectively), and thereby increase the student's Claustrophobic subscale score. On the other hand, if the item were: "I NEVER feel closed-in when I am indoors," a student's response of A or B would not be recoded and the resulting value (1 or 2, respectively) would contribute to a lower Claustrophobic subscale score.

A review of the items comprising the three subscales noted by Katz and Rexter as demonstrating inadequate reliability revealed that the scoring for several items had not been reversed when, in fact, it should have been. Specifically, two items in the Problems Subschool subscale and three in the Self Criticism subscale were not reverse-scored. The third subscale that Katz & Rexter identified as having inadequate reliability, the Uncertain About Submarines subscale, suffered because of the inappropriate inclusion of a single item that correlated negatively with other subscale items, and because of an item with a large number of missing responses.

As presented in Table 1, the alpha reliability of these three subscales fell well within acceptable limits once the scores for the problematic items were reversed and a single item was eliminated from the Uncertain About Submarines subscale.³

Several other subscales needing minor modification were noted by Katz and Rexter. The difficulties found in these subscales fell basically into two categories -- subscales with items that correlated negatively with other subscale items, and subscales with items having too many neutral or missing

³ It should be noted that the removal of this item from its subscale occurred after Katz and Rexter's analysis, not as a part (or consequence) of the current investigation.

responses. Those in the first category included items found in the Social Isolate, Impulsive, and Dependency subscales. The scoring for one item in each of these subscales was reversed in order to correct the negative correlation. Those in the second category included items from the Coercive Attitudes, Aggressive/Destructive, and Unconditional Submarine subscales. The items from the subscales in this second category are currently under review and may be modified or excluded in the future.

Results of the analysis of the subscales that suffered due to missing item responses again paralleled Katz and Rexter's findings. Two items in the Coercive Attitudes subscale, two items in the Unconditional Submarine subscale, and one item in the Uncertain About Submarines subscale were associated with this problem. While an additional 13,000 individuals have been tested since Katz and Rexter's 1990 analysis, the problem items previously identified remain a source of difficulty. However, neither Katz and Rexter's work nor the current study address the manner in which the items' content is questionable. That is, it may be that the wording of some of these questions is outdated or obscure (e.g. "I believe that might makes right"), or simply that some of these questions are too pointed (e.g. "I would prefer to serve under a commanding officer who is easy").

The adequacy of the current means and standard deviations was explored by calculating the means and standard deviations of the standardized scores and examining the probabilities associated with these means. Table 2 presents those data for the four subscales that demonstrated the greatest deviation from 1990 values: the Impulsive, Uncertain About Submarines, Problems Submarine School, and Self

Criticism subscales. The probabilities associated with the means obtained from these subscales' Z scores were less than .2 ($p < .2$). This finding is not surprising in light of the fact that the scoring of the problem items for these subscales (the items correlating negatively with other subscale items) was corrected (reverse-scored) before the renorming procedure was performed. This alone could account for the magnitude of change in the means and standard deviations for the four most problematic subscales. The minor fluctuations found in many of the remaining subscales necessitate the implementation of the new means and standard deviations to update the scoring process.

The use of the new means and standard deviations is not only supported by our empirical findings, but also by the literature as well. Good test construction and maintenance practices dictate that the instrument be renormed periodically in order to ensure continued accuracy in the calculation of standardized scores (Cronbach, 1990). Further, the inclusion of nearly 13,000 new observations to the dataset adds meaningful information towards accurate renorming. As Cronbach notes, "When the sample is properly distributed, a larger sample gives better norms" (1990, p. 128).

Conclusion

All 25 SUBSCREEN subscales displayed moderate to high reliability after corrections were made to the scoring of a number of items and a single item was omitted from one subscale. The researchers found that all of the problem items noted by Katz and Rexer fell into two categories. Those that Katz and Rexer identified as being negatively correlated with other

subscale items were, in fact, simply scored incorrectly. The C code scoring routine that is utilized on a weekly basis has been updated to properly score all 240 SUBSCREEN items. Documentation relating to the changes and the rationale for them has been incorporated into the code and each response sheet will be annotated to note that the revised scoring method was used.

The five problem items that were identified in 1990 as having too many missing or neutral responses were confirmed in the current study. These items are being reviewed. They may need to be re-worded or perhaps discarded from the inventory.

Beyond the fluctuations found in the four problem subscales, results indicated that small variations in the means and standard deviations of many of the remaining subscales have occurred. As part of the continual upkeep of SUBSCREEN, new means and standard deviations for all SUBSCREEN subscales have been included in the scoring program. Finally, the authors recommend that renorming be conducted biannually to ensure continued accuracy in correctly identifying enlisted men at risk.

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